Department of Biochemsitry, UCS&I,
Mahatma Gandhi Univeristy, Nalgonda. Approved MSc. CBCS Syllabus
(Effective for 2016-17 admitted batch onwards)

	SEMESTER I					
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI101T:Chemistry and Metabolism of Proteins and Lipids and Porphyrins (core)	4	4	4	20	80
2	BI102T:Chemistry and Metabolism of Carbohydrates, NucleicAcids and Vitamins (core)	4	4	4	20	80
3	BI 103T: Bio-AnalyticalTechniques (core)	4	4	4	20	80
4	BI104T:Bioenergetics and CellBiology (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	Add on paper	2	2	2	10	40
5	BI105P:Biomolecules	9	6	4	--	100
6	BI106P:BioanalyticalTechniques	9	6	4	--	100
	Total	38	32	27	90	585
	SEMESTER II					
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI201T:Enzymology (core)	4	4	4	20	80
2	BI202T:Molecular Biology (core)	4	4	4	20	80
3	BI203T:BiochemicalGenetics and Model Organisms (core)	4	4	4	20	80
4	BI 204T: Endocrinology and Metabolic Disorders (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	Add on paper	2	2	2	10	40
5	BI205P:Enzymology and Biochemical preparations	9	6	4	--	100
6	BI206P:Molecular Biology and Endocrinology	9	6	4	--	100
	Total	38	32	27	90	585
	SEMESTER III					
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI301T:Gene Regulation and GeneticEngineering (core)	4	4	4	20	80
2	BI302T:ImmunologyandImmunotechnology (core)	4	4	4	20	80
3	BI303T: clinical Biochemistry/Nutrition (Elective)	4	4	4	20	80
4	BI304T: Human physiology and xenobiotics (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	#Inter Disciplinary paper-I (ID paper-I) Chemistry of Biomolecules and Methods of study	4	4	4	20	80
5	BI305P:RecombinantDNA and Immunotechnology	9	6	4	--	100
6	BI306P:Nutrition and ClinicalBiochemistry	9	6	4	--	100
	Total	40	34	29	100	625
	SEMESTER IV					
PAPERS	TITLE (WITH CODE)	Teaching hrs/week	Workload/ week	Credits	Internal marks	Final exam marks
1	BI401T: Biostatistics and Bioinformatics (core)	4	4	4	20	80
2	BI402T: Cell-Cell Communication and SignalTransduction (core)	4	4	4	20	80
3	BI403T: Microbiology (core)	4	4	4	20	80
4	BI404T: Biotechnology (core)	4	4	4	20	80
	Seminars	2	2	1	--	25
	#ID paper-II: Health and Immune System	4	4	4	20	80
5	BI405P:Bioinformatics, Biostatistics and Biotechnology	9	6	4	--	100
6	BI 406 P: Project	9	6	4	--	100
	Total	40	34	29	100	625

	Sem-I	Sem-II	Sem-III	Sem-IV	Total
No. of credits	4+4+4+4+1+2+4+4=27	4+4+4+4+1+2+4+4=27	4+4+4+4+1+4+4+4=29	4+4+4+4+1+4+4+4=29	112
Marks	675	675	725	725	2800
Total work load of (Sem-I, Sem-III)					*56
Total work load of (Sem-II, Sem-IV)					*56

*Note: work load without add on paper, ID papers and seminars
#ID papers: for other than M.Sc. Biochemistry course students

Semester I

Paper-I: BI 101T: Chemistry and Metabolism of Proteins and Lipids &Porphyrins (4Credits; 100 Marks)

Unit–I:ChemistryofAminoAcids,&Proteins

1. Classification and structure of 20aa,essential,non–essential,unusual and non-protein
2. General properties of aa, acid–base titrations, pKa
3. Peptidebond–stability and formation,Primarystructure,GN Ramachandranplots
4. Secondarystructure and motifs,αhelix,βsheet,3-10helix
5. Leucinezipper,Zincfinger,Trans-membraneregions, βLHL
6. Tertiary&Quaternarystructure(myoglobin,hemoglobin)
7. Protein-proteininteractions(actin, tubulin)
8. Smallpeptides(glutathione,peptidehormones),Cyclicpeptides (Gramicidin)
9. Classificationofproteins-globular,fibrous,membrane,metallo-proteins,SCOP,CATH
10. Denaturation (pH,temperature,chaotropicagents),refolding, Role of chaperones in folding

Unit–II:MetabolismofAminoacids,&Proteins

1. Metabolicfate of dietary proteins and aminoacids
2. Degradations to glucose and ketonebodies
3. Aminoacids degraded to Pyruvate,Oxaloacetate
4. Aminoacids degraded to Acetyl-CoA,Succinyl-CoA
5. Metabolism of branched chain aminoacids
6. Role of glutamate cycle in formation&circulation of ammonia
7. Glucose alanine cycle,ureacycle
8. Linking of citricacid and ureacycles,regulation of ureacycle
9. Genetic defects in metabolism of aminoacids(albinism,Phenylketonuria, maple syrup urine disease,homocystinuria, alkaptonuria,methyl malonic Acidemia)
10. Genetic defects in metabolism of urea (Argininemia,Arignosuccinic Acidemia, Carbamoyl Phosphate Synthetase-I deficiency)

Unit–III:Chemistry of Lipids &Porphyrins

1. Classification & biological significance of lipids & fattyacids
2. Steroids,Sterols,relation to vitaminD and steroid hormones
3. Bileacids and salts,Phospholipids
4. Oils,waxes,isoprene units
5. Lipoproteins
6. Glycolipids,Sphingolipids
7. Structure&functionofporphyrins(e.g.Heme,Chlorophyll)
8. Cerebrosides,Gangliosides
9. Prostaglandins,Prostacyclins
10. Thromboxanes,Leukotrienes

Unit–IV:Metabolism of Lipids&Porphyrins

1. Fate of dietary lipids and Apo-lipoproteins
2. Fattyacid biosynthesis,Desaturation of fattyacids
3. Betaoxidation,breakdown of odd chain fattyacids,energy yields
4. Regulation of β–oxidation,ώ–oxidation & α–oxidation
5. Metabolism of phospholipids & Sphingolipids
6. Regulation and Biosynthesis of cholesterol and othersteroids
7. Fate of acetylCoA,formation of ketonebodies and ketosis
8. Biosynthesis of prostaglandins,Prostacyclins,Thromboxanes,Leukotrienes
9. Role of HDL,LDL,andVery-low-density lipoprotein(VLDL) and cholesterol levels in body
10. Catabolism of Porphyrins,Genetic defects in lipid and nucleotide metabolism, Medium chain acyl coenzymeA dehydrogenase deficiency MCAD,Long-chain3-hydroxyacyl-CoAdehydrogenase(LCHAD)deficiency,Familial hyper cholesterolemia,Gout

References:

1.LehningerPrinciplesofBiochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman.2.Biochemistry-JeremyMBerg,JohnLTymoczko,andLubertStryer.:WHFreeman
3.Biochemistry,4thEdition-DonaldVoet,JudithG.Voet.–PublisherJohnWiley&Sons.

PaperII BI102T:Chemistry Metabolism of Carbohydrates, NucleicAcids and Vitamins.(4Credits;100Marks)

Unit–I: Chemistry of Carbohydrates

1 Classification,monosaccharides (aldoses&ketoses)
2 Configuration and conformation of monosaccharides(pyranose&furanose,chair&boat)
3 Reducing and optical properties of sugars
4 Stability of glycosidic bond disaccharides,oligosaccharides
5 Structural polysaccharides-cellulose,hemicellulose,pectin,lignin,chitin,chitosan
6 Storage polysaccharides:starch,glycogen,inulin
7 Steric factors in polysaccharides folding,sugar code and lectin
8 Glycosaminoglycans,mucopolysaccharides,hyaluronicacid
9 Chondriotinsulfate,keratansulfate,dermatansulfate
10 Bacterialcellwall–proteoglycansandpeptidoglycans

Unit–II:Metabolism of Carbohydrates

1 Reactions and energy balance in Glycolysis
2 Reactions and energy balance in Gluconeogenesis
3 Reactions and energy balance in TCAcycle
4 Pentose phosphate,Pasteur and Crabtreeeffect
5 Anapleurotic reactions
6 Glyoxylate cycle
7 Glucuronicacid cycle
8 Glycogen metabolism
9 Photosynthesis reactions for biosynthesis of glucose
10 C3andC4cycle in plants

Unit–III:Chemistry and Metabolism of NucleicAcids

1 Purines,pyrimidines,nucleosides,nucleotides,unusualbases2
Structure of DNA–Watson Crick Model,A-andZ-forms
3 Supercoiling of DNA–negative and positive,linking number
4 Structure of RNA,tRNA,rRNA,siRNA/miRNA
5 Properties of NA–denaturation and renaturation
6 Tm(factorsaffectingT_m) and $C_o t$ curves
7 Heteroduplex mapping–D loops and Rloops
8 Biosynthesis of purines and pyrimidines
9 Degradation of purines and pyrimidines
10 Regulation:*denovo*,salvation,nucleotide analogs

Unit–IV:Chemistry and Metabolism of Vitamins

1 Discovery of vitamins,classification, RDA
2 VitaminA–source,biological role,deficiency
3 VitaminB1–Thiamine–source,biological role,deficiency
4 VitaminB2–Riboflavin–source,biological role,deficiency
5 VitaminB3–Niacin and B5–Pantothenicacid–sources,biological role,deficiency
6 VitaminB6–Pyridoxamine and B7–Biotin–source,biological role,deficiency
7 VitaminB9–Folicacid and B12–Cobalamine–source,biological role,deficiency
8 VitaminC–Ascorbic acid–source,biological role,deficiency
9 VitaminD–Calciferol–source,biological role,biological role,deficiency
10 VitaminE,VitaminK–source,biological role,deficiency

References:

1.LehningerPrinciplesofBiochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman.2.Biochemistry-JeremyMBerg,JohnLTymoczko,andLubertStryer.:WHFreeman
3.Biochemistry,4thEdition-DonaldVoet,JudithG.Voet–PublisherJohnWiley&Sons
4.PrinciplesofBiochemistry:MammalianBiochemistry:SmithEL,HillRL,…WhiteA,McGrawHill

PaperIII BI103T: Bioanalytical Techniques.(4Credits;100!Marks)

Unit–I:Spectroscopy

1 Beer Lambert's Law,Molar extinction coefficient,Absorption maximum
2 UV-Vis:Spectroscopy,Colorimetry–principle,instrumentation,application
3 Fluorescence Spectroscopy–principle,instrumentation,application
4 Atomic Absorption Spectrometry–principle,instrumentation,application
5 NMR–principle,instrumentation application
6 ESR–principle,instrumentation application
7 CD–principle,instrumentation,application
8 ORD–principle,instrumentation,application
9 Masss pectroscopy principle,instrumentation,application
10 X-raycrystallography

Unit–II:Chromatography

1 Partitioning and countercurrent distribution
2 PC–principle,instrumentation,application
3 TLC–principle,instrumentation,application
4 GC–principle,instrumentation,application
5 Ion–exchange–principle,instrumentation,application
6 Gel filtration(Gel exclusion chromatography)–principle,application
7 Affinity chromatography–principle instrumentation,application;immunoprecipitation
8 HPLC and RP-HPLC–principle,instrumentation,application
9 FPLC,LC–principle,instrumentation,application
10 Peptide mapping and N-terminal sequencing of proteins

Unit–III:CentrifugationandElectrophoresis

1 Centrifugation,RCF and types of rotors
2 Ultra centrifugation–principle,instrumentation,application
3 CsCl density gradient and sucrose gradient centrifugation–principle,application
4 Electrophoresis–moving boundary and zonal electrophoresis
5 Native and SDSPAGE,IEF and 2DPAGE
6 Agarose Gels,PFGE
7 Zymography,PAGE for DNA sequencing
8 DNase-I hypersensitivity mapping
9 DNA-Foot-printing and Chromatin IP methods
10 Denaturing gels for RNA,Southern and Northern Blots

Unit–IV: TracerTechniques

1 Stable and radioactive isotopes,Radioactivity theory,halflife and emission spectra of Halflife of biologically useful isotopes-^{2}H, ^{3}H,^{14}C, ^{18}O,^{32}P,^{35}S,^{125}I
2 Isotopes used for labelingproteins($^{3}H$$^{14}C$,$^{35}S$,$^{125}I$)and nucleicacids($^{3}H$,$^{32}P$)
3 Detection of radioactivity by Scintillation counting
4 Autoradiography,Fluorography,Phosphor-imaging,applications
5 GMcounter,gammacounter
6 Radiation hazards and safe disposal of radioactivity waste; Luxometry and chemiluminescenceas alternative to radioactivity
7 Isotope dilution method–pulse chase
8 Historic examples-^{14}C and^{18}O to study photosynthesis
9 Historic examples-^{31}P and^{32}S to study viral replication (Hershey-Chase experiment)
10 Historic examples- ^{14}N and ^{15}N in DNA replication(Meselson and Stahl experiment)

References:

1.Principles andTechniques of Practical Biochemistry-Wilson.K.AndWalker.J.Pub:CambridgePress2.PhysicalBiochemistry-Friefelder,PublisherD.W.H.FreemanPress
3.BiophysicalChemistry:PrinciplesandTechniques,2ndeditionbyA.Upadhyay,K.Upadhyay andN.Nath.HimalayaPublishingHouse,Delhi.
4.LehningerPrinciplesofBiochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman5.TheToolsofBiochemistry,CooperTG,JohnWileyandSons

PaperIV: BI104T:Bioenergetics and CellBiology.(4Credits;100!Marks)

Unit–I:Bioenergetics

1 Elementsofimportanceinbiochemistry(H,C,N,O,P,S),typesandenergy of bonds and interactions(ionic,covalent,coordinate,H-bonds,vanderWaals,hydrophobicinteractions)
2 Laws of thermodynamics,Gibbs free energy,relevance of entropy and Enthalpy in biological systems and reactions; First and second-order reactions
3 **Log** and **ln** scales in biological processes (exponential growth curves,radio active decay)
4 Biological oxidation,high energy compounds
5 High energy bonds, redox and phosphate potential
6 Structure of membrane,forces stabilizing membranes
7 Formation of iongradients across a membrane(protongradientsinorganelles),role of transporters and channels
8 ETC in mitochondria and chloroplasts,un-couplers and inhibitors of energy transfer
9 Polarization of cell,resting potential,action potential,propagation of impulse
10 Biological fluorescence (GFPandderivatives),Bioluminescence

Unit–II: Structure of Prokaryotic cells

1 Classification of prokaryotes(systems of classification)
2 Ultra-structure of eubacteria,cyanobacteria,mycoplasma
3 Motility of bacteria,bacterial films,isolation of bacteria from natural sources
4 Sterilization of materials (autoclaving,dryheat,filtration,chemical disinfection,irradiation) and commonly-used media(minimal,enriched,selective)for bacterial growth
5 Staining methods for bacteria;maintenance,and preservation of bacterial cultures
6 Growthcurve,Doubling time,Factors effecting growth–pH,temperature,oxygen,agitation
7 Batch and continuous growth of bacteria,chemostat,synchronized cultures
8 Industrial(large-scale)growth of bacteria,fermenter design
9 Bacteria of industrial importance,development of commercially valuable strains
10 Discovery of antibiotics,mode of action of various classes of antibiotics,antibiotic resistance

Unit-III: Structure of Eukaryotic cells

1 Ultra-structure of animalcells
2 Ultra-structure of plantcells
3 Composition of cytoskeleton-microfilaments,microtubules,intermediate filaments
4 Nuclear skeleton-lamina,scaffold
5 Vesicle trafficking (endocytosis,exocytosis),role of Rabs and Rab GTPases
6 Structure of chromatin and chromosomes (centromere,telomere,kinetochore)
7 Mitosis, meiosis, and interaction of chromatin with cytoskeleton (attachment of spindle fibers).
8 Formation and structure of special chromosomes (polytene,lampbrush)
9 Cellcycle
10 Apoptosis

Unit–IV:Methods of Cell Study

1 Simple and compound microscope.
2 Phase contrast,dark field and polarization microscopy.
3 Electron microscopy,SEM,TEM;freeze fracture.
4 Fluorescence and Confocal microscopy;imaging live cells.
5 FRET and FRAP.
6 Atomic force microscopy.
7 Flow-Cytometry and cellsorting(FACS).
8 Plant tissue culture.
9 Animal and insect tissue culture.
10 Methods of cell disruption and fractionation,isolation of organelles.

References:

1.LehningerPrinciplesofBiochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman2.MolecularBiology oftheCell,3rdedition.BruceAlberts,DennisBray,JulianLewis, MartinRaff,KeithRoberts,andJamesDWatson.PublisherNewYork:GarlandScience;3.TheCell:A MolecularApproach,FifthEdition,byGeoffreyM.Cooperand RobertE.Hausman,publishedbyASMPress

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Semester I:Practicals
(Note:Each topic corresponds one practical session)

PaperV:BI105P:Biomolecules	**PaperVI:BI106P:BioanalyticalTechniques**
1Lab safety, GLP, calculations and preparation of standard solutions 2Preparation of buffers, use of balance and pH meter 3Qualitative analysis of amino acids 4Determine **pKa** and **pI** of acidic, basic, and neutral amino acids 5Estimate amino acids by Ninhydrin methods 6Quantify glycine by formal titration 7Estimate tryptophan by Spies and Chambers method 8Qualitative analysis of carbohydrates 9Estimate total sugars by phenol sulfuric acid method 10Estimate reducing sugars by DNS 11Estimate fructose by Roe's method 12Qualitative analysis of lipids 13Saponification value of fats 14Iodine number of oil 15Peroxide value of fats 16Acid value of fats 17Estimate DNA by DPA 18Estimate RNA by Orcinol- Method 19SDS PAGE for proteins 20Agarose gel for DNA	1Absorption spectrum of tyrosine, determination of molar extinction coefficient, calculations based on Beer Lambert's Law 2Estimate inorganic phosphate by Fiske-Subbarow method 3Estimate protein by Biuret method 4Estimate protein by Lowry method 5Titrate calcium in milk 6Titrate vitamin C 7Photometric analysis of iron 8AAS analysis of metals 9Anion-exchange capacity of resin 10Cation-exchange capacity of resin 11Separate amino acids by ion-exchange chromatography 12Separate purines and pyrimidines by paper chromatography 131-D PC of amino acids 142-D PC of amino acids 15PC of plant pigments 16TLC of plant pigments 17TLC of lipids 18Desalting proteins by dialysis 19Gel filtration (size exclusion) 20Cell fractionation (centrifuge)

Project ideas:

1Compare pigments in different plant parts, different flowers, plants and algae
2Compare unsaturation of various oils and fats
3Determine sugar /vitamin C content in various fruits and soft drinks, calcium content in various milk brands

References:

1.An introduction to practical biochemistry. By: David T Plummer. Publisher Tata McGraw- Hill
2.BiochemicalCalculations–Segel,I.H.JohnWiley&sons
3.Experimental Biochemistry: A Student companion- SashidharRao, B and Deshpande, V. IK International (P) Ltd
4.Experiments And Techniques In Biochemistry: by Sheel Sharma, Galgotia publications.

Semester II
Paper-I: BI 201T:Enzymology. (4 Credits; 100 Marks)

Unit–I:Enzymes, Coenzymes and catalysis

1 Thermodynamics of catalysis,Energy of activation,Relation of ΔG and K_{eq}
2 Coupled reactions(endergonicandexergonic)in biochemical pathways
3 Methods to isolate and purify enzymes,Assays,Activity Units,Specificactivity
4 Nomenclature and classification of enzymes:EC,SCOP,CATH
5 Metal,co-factor,and co-enzyme requirements
6 Vitamin cofactors:TPP,FMN/FAD,NAD/NADP,Pantothenicacid
7 Vitamin cofactors:PLP,Biotin,Folate,Cobalamine,Phylloquinone
8 Factors affecting catalysis(pH,temperature,pressure,enzyme and substrate concentration)
9 Chemicals to identify active site residues:Arg,Cys,Lys,His
10 Site-directedmutagenesis to identify active site residues:Triose Phosphate Isomerase

Unit–II: Enzyme Kinetics

1 Single substrate assumptions,Briggs-Haldane equation.
2 Steady state,Michaelis-Mentonkinetics(derive equation and transformations)
3 Transformation of Michaelis-Menton equation.
4 Bi substrate reactions:ordered,random,sequential,Ping-Pong
5 Distinction between ordered and random addition of substrates and products release.
6 Inhibitors (competitive,uncompetitive,noncompetitive,suicide),effect on kinetic constants
7 Enzyme inhibitors as drugs:RT and Protease inhibitors as anti-HIVdrugs
8 Cooperativity in binding(oxygen binding to hemoglobin)
9 Multiple sites;Cooperativity:MWCmodel,KNFmodel
10 Slow transition and Hysteretic behavior in enzymes

Unit–III:CatalyticMechanisms

1 Types of catalysis:acid-base,transition state,covalent intermediates
2 Reversible and irreversible activation of enzymes (pro-enzymes,phosphorylation)
3 Enzymes activation by ligand binding and dimerization(protein tyrosine kinase receptors)
4 Catalytic mechanism of RNase
5 Catalytic mechanism of Chymotrypsin,Trypsin
6 Catalytic mechanism of Lysozyme
7 Catalytic mechanism of Carboxy peptidase,Subtilisin
8 Allosteric regulation of Aspartate Transcarbamylase
9 Regulation of Glutamine Synthetase
10 Multi-enzyme Complex: fatty acid synthase

Unit–IV:Enzymes in Physiology and Biotechnology

1 Regulatory enzymes in carbohydrate metabolism (glycolysis, TCAcycle)
2 Regulatory enzymes in nucleotide metabolism
3 Enzyme cascades (blood clotting,complement activation)
4 Enzyme cascades(cell division and apoptosis)
5 Convergent and divergent evolution of enzymes
6 Reporterenzymesforgeneexpression(β-gal,β-glucuronidases,CAT);
Restriction enzymes and ligases in recombinant DNAtechnology
7 Enzymes in dairy (Rennin,lipases,lactases),brewing(amylases,proteases,glucanases),
Foodprocessingtechnology(invertase,pectinases,papain)
8 Enzymes in detergent(lipases,cellulases,proteases), paper(cellulases),and tanning
9 Enzymes in bioremediation,biofuel industry(cellulases)
10 Enzyme engineering:Catalytic RNA and antibodies;Designing High-Through put enzyme assays

References:

1.FundamentalsofEnzymology,Price.NC.AndStevens.L.,OxfordUniversityPress
2.Enzymes-Biochemistry,Biotechnology,Clinicalchemistry-Palmer,T.,AffiliatedEast-Westpress3.FundamentalsofEnzymeKinetics,SegelIH;WileyInterscience,

4.Biochemicalcalculations,2ndEditionByIrwinH.Segel.JohnWiley&Sons,
5.LehningerPrinciplesofBiochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman!

PaperII: BI202T:Molecular Biology.(4Credits;100Marks)

Unit–I:DNAReplication

1 Models of replication–random,conservative,semi conservative
2 Prokaryotic and eukaryotic DNApolymerases,helicases, ligases, topoisomerases
3 Initiation–primosome,ori-sequences,accessory proteins
4 Elongation–replisome,leading and lagging strands,Okazaki fragments
5 Termination,Inhibitors of replication
6 Replication of circular chromosomes by theta model-φX174,E.coli
7 Replication of circular chromosomes by rolling circle (lambdaphage) and Strand displacement models (mt-DNA)
8 Replication of linear chromosomes,telomeres,telomerase
9 Amplification–Polytene and double minute chromosomes
10 *Invitro* replication-PCR

Unit–II:DNARepair

1 Types of damage–oxidation,deamination,alkylation,adducts,breaks
2 Direct repair–MGMT,photo-reactivation,AlkB
3 Base Excision Repair(Short and LongPatch)
4 Nucleotide Excision Repair
5 Mismatch Repair
6 Repair of DSBs by NHEJ and Homologous recombination
7 Holliday junctions and repair of collapsed forks
8 SOS and bypass repair
9 Diseases due to defects in DNA repair
10 Roles of ATM,BRCA in DNArepair

Unit–III:TranscriptionandTranslation

1 Prokaryotic and eukaryotic RNApolymerases
2 Initiation–prokaryotic and eukaryotic promoter sequences
3 Elongation,Termination–rho dependent and independent
4 Post-transcriptional modifications-capping,PolyA addition
5 Splicing,RNAediting;Inhibitors of transcription
6 Structure of ribosome,nature of geneticcode
7 Initiation of translation (roleofcap,IRESIFs)
8 Elongation of translation (roleofEFs)
9 Termination of translation (roleofRFs)
10 Inhibitors of protein synthesis

Unit–IV:Protein Sorting, Targeting and degradation

1 Post translational modifications of proteins, role in targeting (isoprenylation)
2 Signal peptide(ERLS),role of SRP in translation of secreted proteins
3 NLS, Mitochondrial & chloroplast LS
4 Chaperones,HSPs in proteinfolding
5 Lysosomal pathways (endocytosis,crinophagy,macroautophagy, Micro autophagy,direct translocation from cytosol)
6 Lysosomal storage diseases
7 Ubiquitin-proteasome pathway, N-endrule
8 Immuno-proteasomes, Misfolded proteins in neuro degenerative diseases,
9 PESTsequencesandproteolysis
10 Action of cytotoxic,hemotoxic,myotoxic & hemorrhagic venoms

References:

1.LehningerPrinciplesofBiochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman.2.MolecularBiology oftheCell,3rdedition.BruceAlberts,DennisBray,JulianLewis,MartinRaff, KeithRoberts,andJamesDWatson.PublisherNewYork:GarlandScience;
3.Biochemistry,4thEdition-DonaldVoet,JudithG.Voet–PublisherJohnWiley&Sons
4.TheCell:AMolecularApproach,byGeoffreyM.CooperandRobertE.Hausman,pub.ASMPress

Paper-III: BI 203T: Biochemical Genetics and Model Organisms.
(4 Credits; 100Marks)

Unit–I:Mendelian Genetics

1 Mendel'sLaws,Importance of meiosis in heredity
2 Non-Mendelian Inheritance–Maternal effect,Maternal influence,Cytoplasmic inheritance
3 Gene interactions-Epistasis,Expressivity,Penetrance
4 Sexlinked, sexlimited,and sex influenced genes;Polygenic inheritance and polyploidy
5 Mutations (spontaneous/induced,somatic/germinal,forward/reverse,transition/transversions)
6 Mutations (Silent,missense,nonsense,andframeshiftmutations,conditional,leaky)
7 Detection, selection & isolation of microbial mutants,Estimation of mutation rates
8 Reversion and suppression of mutations
9 Mutagens–physical,chemical
10 Transposon mutagenesis,site-directed mutagenesis

Unit–II:Linkage and Mapping

1 Discovery of linkage,Morgan'sexperiments
2 Cytological proof of crossing over
3 2-and3-point crosses
4 Recombination,Interference
5 Tetrad analysis
6 Mapping humangenes by pedigree analysis;Fundamentals of population genetics(HWLaw)
7 Pedigrees of AR,AD,XR,andXD inherited traits
8 Mobile genetic elements–Zea Ac,DsandSpmelements
9 *Drosophilacopia*,Yeast Ty elements
10 Using recombination to make knockout cells/organisms

Unit–III:Bacterial Genetics

1Discovery of conjugation
2Mapping bacterial genes by conjugation
3Discovery of transformation
4Mapping bacterial genes by transformation
5Discovery of transduction
6Mapping Bacterial genes by transduction
7Discovery of transposition
8Structure of transposons,replicative and conservative transposition,use as mutagens
9Mapping phage genes–Fine structure of rIIlocus:Complementation analysis
10Fine structure of rIIlocus:Deletion mapping

Unit–IV:Model Organisms

1*Dictyostelium* to studycell–cell communication and differentiation.
2*Saccharomyces* to study homologous recombination in mating type switch;site of formation of buds
3*Neurospora* to study one gene–one enzyme hypothesis
4*Drosophila* to study embryonic development(homeotic mutations)
5*C.elegans* to study development and nervous system
6*Danio* to study vertebrate development,GLOfish
7*Xenopus* to study embryogenesis
8*Mus* in bred and knockout strains,NOD and nudemice
9*Zea* to demonstrate cytological proof of crossingover
10*Arabidopsis* to study flower development

References:

1. Microbiology–PrescottLM,HarleyJP.&KleinDA,McGraw-Hill
2. PrinciplesofGeneticsbyEldonJohnGardner,MichaelJ.Simmons,D.PeterSnustad;JohnWiley3. ModernGeneticAnalysisAnthonyJFGriffiths,WilliamMGilbert,JeffreyHMiller,andRichardC Lewontin.Pub.W.H.Freeman;

Paper-IV: BI 204T: Endocrinology and Metabolic Disorders.(4 Credits; 100 Marks)

Unit–I:Hormones and Endocrine glands

1. History of endocrinology
2. Organization and classification of hormones and endocrine systems
3. Basic mechanism of action of peptide hormones and receptors
4. Basic mechanism of action of steroid hormones and receptors
5. Chemistry,physiology,and disorders related toHypothalamus-Pituitary axis
6. Chemistry,physiology,and disorders related to thyroid and parathyroidglands
7. Glycoprotein hormones(LSH,FSH,TH,hCG,POMC)
8. Growth hormone family(GH,hCS,Prolactin)
9. Adrenal hormones
10. Gonadal hormones

Unit–II:Endocrine regulation

1. Regulatory pathways (positive,negative,feedbackloops),Regulation of biosynthesis of steroid hormones by peptide hormones(LH,FSH,ACTH)
2. Endocrine regulation of growth
3. Endocrine regulation of stress
4. Endocrinology of Cahomeostasis
5. Endocrinology of blood sugar,hunger,digestion,andobesity
6. Endocrine regulation of renal function
7. Endocrine regulation of cardio vascular system (angiotensin,BNP,ET1)
8. Endocrinology of fertility (changesinmenstruation,pregnancy,andmenopause)
9. Medical uses of steroid hormones (contraception,HRT,hydrocortisone,anabolicsteroids)
10. Erythropoietin,Adipo-cytokines,Orexins

UnitIII:Disorders of AminoAcid and Carbohydrate Metabolism

1. Hyper phenyl alaninemia
2. Disorders of proline and hydroxyl proline metabolism
3. Alcaptonuria
4. Disorders of lysine metabolism
5. Disorders of tyrosine metabolism
6. Hemoglobinopathies;Thalassemia
7. Disorders of glycogen storage
8. Disorders of fructose metabolism
9. Disorders of Galactose metabolism
10. Pentosuria, Diabetes

Unit–IV:Disorders of Lipids and Nucleic Acids Metabolism

1. Disorders of acid Lipase deficiency
2. Farber'sdisease
3. Neeman-Picks disease
4. Goucher'sdisease
5. Krabbe disease
6. Sulphatide-lipidosis disease
7. Fabry disease
8. Downs andTurner's syndrome
9. Hyperuricemia and Gout
10. Heriditary Xanthine Urea and Lesch-Nyhan syndrome

References:

1.WilliamsTextbookofEndocrinology– Larsen,R.P.Korenberg,H.N.Melmed,S.andPolensky,K.S.Saunders.

2.HumanPhysiology–Chatterjee.C.C,MedicalAlliedAgency

3.PrinciplesofBiochemistry:MammalianBiochemistry:SmithEL,HillRL,…WhiteA,McGrawHill4.Themetabolicbasisof Inheriteddiseases(VolI&II)ScriverCR..ValleD,PubMcGrawHill

Semester II: Practicals
(Note:Each topic corresponds one practical Session)

Paper-V:BI205P:Enzymology and Biochemical preparations	**Paper-VI:BI206P:Molecular biology and Endocrinology**
1 Assay urease (horse gram / any source) 2 Assay catalase (liver / any source) 3 Assay α amylase (saliva) 4 Assay β amylase (sweet potato) 5 Purify the enzyme; calculate yield, total activity and specific activity at each stage 6 Time course and enzyme concentration (salivary amylase) 7 Effect of pH on enzyme activity 8 Effect of temperature on enzyme activity 9 Effect of [S], determine $K_m$and V_{max} 10 Purify casein from milk, calculate yield at each step 11 Purify albumin from egg, calculate yield at each step 12 Fractionate BSA by salt precipitation 13 Isolation of starch from potato 14 Isolation of glycogen from liver 15 Isolation of lecithin and cholesterol from egg yolk	1 Isolate DNA (onion/thymus/other source), 2 Absorption spectrum to assess purity (A260/A280 ratio) 3 Determine T_m of DNA 4 Prepare RNA (yeast/other source) 5 Agarose gel for RNA, DNA 6 Over expression of a cloned protein 7 Purification of a cloned protein 8 Absorption spectrum, molar extinction coefficient of purine/pyrimidine 9 Estimation of h HCG 10 Estimation of FSH 11. Estimation of LH 12. Estimation of Estrogen, Estradiol 13. T3, T4, TSH Tests (demonstration) 14. Pregnancy Test (strip method) 15. Estimation of C Peptide

Project ideas:

1Compare abundance of an enzyme in various sources
2Compare sensitivity and/or specificity of different assays for the same enzyme
3Find the effect of some treatment (drug) on your model organism
4Screen natural sources for biodiversity (bacteria, phage, algae, antibiotic-resistant bacteria)

References:

1.Enzyme assays-APracticalApproach,Eisenthal,RandDawson,MJ,IRLpress
2.Practical Biochemistry-Rameshwar.A,KalyaniPublisher
3.Principles of Genetics by EldonJohnGardner,MichaelJ.Simmons,D.PeterSnustad;JohnWiley
4.Modern Genetic Analysis AnthonyJF Griffiths,WilliamMGelbart,JeffreyHMiller,andRichardC Lewontin.Pub.W.H.Freeman;
5.Statistics,Basic Concepts and Methodology for the HealthSciences DanielWW, PubWileyIndia
6.Lehninger Principles of Biochemistry,DavidL.Nelson,MichaelM.CoxPublisher:W.H.Freeman.

Paper-I: BI 301T: Gene Regulation and Genetic engineering (Core 4 Credits; 100Marks)

Unit – I: Gene Regulation in Prokaryotes and Viruses

1 Operon concept for gene regulation
2 Positive (+ve)&Negative (-ve) control – Lac operon
3 Attenuation – Trp operon
4 Dual promoters – gal operon: Dual function of repressor – ara operon
5 Phase variation in *Salmonella* flagellar protein synthesis
6 Sporulation gene expression in *Bacillus*
7 Riboswitch
8 Anti – termination in lambda phage
9 Lytic / lysogenic switch in lambda phage
10 Control of plasmid copy number

Unit – II: Gene Regulation in Eukaryotes

1 Chromatin structure in active and inactive regions – DNA methylation.
2 Euchromatin, histone acetylation, H2AX foci, histone code
3 Transcriptional control – cell specific expression – promoters, enhancers, Transcription factors
4 Posttranscriptional control – alternative splicing RNA editing.
5 RNA transport and stability.
6 Translational feedback.
7 Gene silencing – inactivation of mammalian X chromosome.
8 Regulation by siRNA
9 Gal operon of yeast.
10 MAT locus and mating type switch in yeast, Antigenic variation in *Trypanosoma*

Unit – III: Genetic Engineering-I

1 Enzymes in rDNA technology: Restriction endonucleases (discovery, properties)
2 Enzymes in rDNA technology: DNA and RNA polymerases
3 Enzymes in rDNA technology: Nucleases, Kinases. Phosphatases, and Ligases
4 Prokaryotic and Eukaryotic vectors (plasmids, cosmids, phage, phagemid, BAC, YAC)
5 Shuttle vectors, Targeting vectors, Expression vectors (insect, plant, mammalian cells)
6 Construction of cDNA and genomic DNA libraries
7 Screening a library (+ve) & (-ve) selection strategies, Preparation of probes
8 Creating KO cells, Cre – Lox systems.
9 Sequencing DNA by Maxam-Gilbert and Sangar method.
10 Sequencing DNA by Pyrosequencing,

Unit – IV: Genetic Engineering-II

1 Yeast 2 hybrid
2 Phage display
3 Reporter genes – GFP, b – gal, luciferase
4 Expression in heterologous systems – bacteria
5 Expression in heterologous system – yeast cells
6 Expression in heterologous system – insect cells
7 Expression in heterologous system – mammalian cells
8 Molecular markers – RFLP, AFLP

9 Random amplification of polymorphic DNA (RAPD), Short tandem repeat, single nucleotide polymorphism (SNP),
10 Ribotyping

References:
1. Genes VIII, Lewin, B, Publish Oxford University Press
2. Principles of Gene Manipulation: An introduction to GE – Old, R. and Primrose, S.B. Blackwell Sci. Pub
3. Molecular Biotechnology Glick, BR and Paternak, JJ. Publish ASM Press
4. Molecular Biology of the Gene by Whatson JD, Losick R. Pub Pearson Education

Paper-II: BI 302T: Immunology and Immunotechnology (Core 4 Credits; 100 Marks)

Unit – I: Components of the Immune System
1 History of immunology
2 Natural & acquired immunity, Specific & non-specific immune response.
3 Cells & organs of immune system
4 Antigenic determinants, Epitopes, Haptens, Properties of strong antigens
5 Adjuvants – types, mode of action, and applications.
6 Classification, structure, and biological properties of immunoglobulins
7 Isotypes, allotype, idiotypes.
8 Theories of antibody formation, Generation of antibody diversity
9 Genomic rearrangements of light and heavy – chain loci in B-cells
10 Genomic rearrangements in T-cell receptor, structure of CD3, CD4, CD8

Unit – II: Events in Immune Response
1 Humoral& cell-mediated immune response
2 Activation of T cells & B cells
3 Kinetics and regulation of primary and secondary immune response
4 MHC proteins structure & functions
5 Antigen processing & presentation
6 Transplantation immunology; Graft Versus Host Disease
7 Complement fixation: pathways and biological consequences
8 Discovery and action of Interferons
9 Cytokines; Inflammation; Role in obesity, cancer
10 Tumor immunology

Unit – III: Immune Disorders
1 Hypersensitivity; Coombs classification
2 Type I-V hypersensitivity
3 Tests for diagnosis of hypersensitivity (Coombs), Tuberculin test
4 Auto immune diseases; classification
5 Study of selected auto – immune disorders of types I – V
6 Immuno- deficiency disorders – primary and secondary deficiencies
7 Gene therapy for ADA deficiency
8 Immunology of AIDS
9 Immunosuppressive drugs/agents & their mechanism of action
10 Immune evasion by bacteria and viruses

Unit – IV: Immunotechnology

1 Production of polyclonal antibodies; Animals models for production of antibodies
2 Methods of antibody purification: Salt precipitation, Affinity chromatography
3 Antigen-antibody binding (Equilibrium dialysis, Surface Plasmon Resonance); Affinity, Avidity
4 Immunoprecipitation methods - gel diffusion (Ouchterlony; Mancini); Immune-electrophoresis (Rocket, counter-, 2-D)
5 Agglutination tests (Direct and indirect), Inhibition of Agglutination, Complement fixation test, Inhibition of complement fixation
6 ELISA, RIA Western Blots; use of antibody staining for FACS
7 Hybridoma technology – production of monoclonal antibodies; applications in research and immunotherapy; antibody engineering
8 History and types of Vaccines; Conventional vaccines - killed, attenuated, and subunit vaccines
9 Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines
10 Schedules of common vaccination, Benefits and adverse consequences of vaccination

References:

1. Kuby Immunology – Edited Thomas J. Kindt, Richard A Goldsby, Publisher WH Freeman & Co
2. Roitt's Essential Immunology, Tenth Edition, Ivan Roitt, Peter Delves
3. Veterinary Immunology: Ian R. Tizard, I.R. Thomson press
4. The Immune System. By Peter Parham Publisher Garland publishing

Paper-III: BI 303T: Clinical Biochemistry-E1 (Elective –I)
(4 Credits; 100 Marks)

Unit – I: Clinical Biochemistry-I

1 Free radical metabolism, ROS in disease
2 Neuro-endocrine regulation
3. Endocrine regulation of growth
4 Endocrine regulation of salt, electrolyte and water, Acid base balance and imbalance
5 Endocrine regulation of calcium & phosphate
6 Specimen collection. Automation and QA in clinical laboratories
7 Examination of Urine & Blood
8 Examination of Sputum & CSF
9 Pregnancy test, prenatal diagnosis & genetic counseling
10 Clinical importance of Enzymes and isoenzymes

Unit – II: Clinical Biochemistry-II

1Physiological Interrelationship between cardiovascular, respiratory and renal systems
2Normal values for different blood tests and clinical implications
3Diagnosis of anemia, thalassemia
4hyper cholesterolemia, atherosclerosis.
5Diagnostic enzymes: Principles of diagnostic enzymology.
6Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase
7Clinical significance of aldolase and lactate dehydrogenase.
8Enzyme tests in determination of myocardial infarction

9Biochemical tests for the diagnosis of heart diseases- HDL/LDL cholesterol, SGOT, LDH, CK, C-reactive protein, cardiac troponins.
10Diagnostic and therapeutic uses of radioisotopes

Unit – III: liver and Renal function tests

1Structure and functions of the liver.
2Liver diseases: jaundice, hepatitis, cirrhosis, Fatty liver
3Liver function tests: conjugated and total bilurubin in serum, albumin: globulin ratio, hippuric acid and bromsulphthalein tests.
4Serum enzymes in liver diseases: SGPT, GGT and alkaline phosphatase.
5Kidneys-structure of nephron, urine formation
6 Normal and abnormal constituents of urine.
7Normal values for different urine tests and clinical implications
8Biological buffers.
9Role of kidneys in maintaining acid-base and electrolyte balance in the body.
10Renal function tests- creatinine and urea clearance tests, phenol red test.

Unit – IV:Clinical aspects of disorders of lipid metabolism and gastric, thyroid function tests

1Physiology of lipids/lipoproteins.
2 Lipidosis.
3lipoproteins and apolipoproteins.
4Disorders of lipid metabolism: lipoproteinemias
5Clinical interrelationships of lipids (sphingo-lipidosis and multiple sclerosis)
6Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders.
7Fractional gastric analysis: Achylia gastric, Stimulation tests, Tube less gastric analysis
8Tests based on primary function of thyroid,Tests measuring blood levels of thyroid hormones,
9Tests based on metabolic effects of thyroid hormones,
10Thyroid scanning, Immunological tests for thyroid functions

References:

1. Text book of Biochemistry and Human Biology –Talwar , G.P. and Srivastava. L.M., Printice Hall of india
2. Human Physiology –Chatterjee.C.C, Medical Allied Agency
3. Textbook of Medical Biochemistry By MN Chatterjea and Rana Shinde, Jaypee Brothers.
4.Lehninger Principles of Biochemistry 5thEdByDavid L. Nelson and MichaelM. Cox,WH Freeman and Company.
5.Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3rdEd
By Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.
6. Harper's Biochemistry (Lange Medical Books) (Paperback)By Robert K. Murray,Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
7.Clinical Biochemistry By Richard Luxton. Scion Publishing Ltd.

Paper-III: BI 303T: Nutrition-E2 (Elective –II)
(4 Credits; 100 Marks)

Unit – I: Nutrition -I

1 Balanced diet
2 Calorific values of foods and their determination by bomb calorimeter.
3 Specific dynamic action of foods
4 Nutritional assessment by clinical testing; Anthropometric and Biochemical testing
5 BMR and RDA for infants, children, adults and expectant / nursing mothers; Food fortification; probiotics
6 Organs of digestive system; Enzymes (amylases, proteases, lipases)
7 Hormones in digestion (stomach, pancreas; gastrin, secretin, CCK);
8 Role of bile acids
9Absorption; Control of food intake (leptin, ghrelin, peptide YY)
10 Cholesterol, sodium and blood pressure

Unit – II: Nutrition - II

1Protein factor in nutrition
2Role of carbohydrates in diet
3Role of lipids in the diet
4Malnutrition (PEM, Marasmus, Kwashiorkor), Obesity (BMI and other metrics)
5Eating disorders; Anorexia and bulimia; Obesity and starvation.
67Diet and longevity, ageing.
7Diet in pregnancy and lactation
8Composition and nutritive value of common foodstuffs
9Electrolyte content of fluid compartments, Functions of electrolyte, Sodium, Potassium and Chloride, Absorption, Transport and balance
10 Factors effecting electrolyte balance and hydrogen ion balance.

Unit – III:Macrominerals and Microminerals

1Macrominerals
2Calcium Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Dificiency, Toxicity, Sources, RDA
3 Regulation of calcium concentration, Calcium interaction with other nutrients.
4Phosphorus Distribution, Concentration in the body, Digestion, Absorption, Utilization, Transport, Storage, Excretion, Sources, Calcium: Phosphorus ratio.
5Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia and hyperphosphataemia
6Iron Distribution, Concentration in the body, Digestion, Absorption, Utilization, Transport, Storage, Excretion, Sources
7 RDA, interaction with other nutrients
8 Role of iron in prevention of anaemia.
9Microminerals: Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Sources, distribution in the human body
10 Physiology, function, deficiency and toxicity of microminerals

Unit – IV: Food Microbiology

1General principles underlying spoilage of food
2fitness and unfitness of food for consumption, contamination and spoilage of non perishable and perishable foods.
3food born diseases, food infection, intoxication
4 microbial toxins types, bacterial poisoning
5Causative agents and sources, symptoms and prevention of Staphylococcal food poisoning, botulism, salmonella, bacillus infection, E.coli,
6food poisoning of fungal origin ergotism, aflatoxin.
7Control of microorganisms
8Principles of preservation, Preservation by high and low temperature,
9chemical preservatives, salt, sugar as preservative
10 new trends in preservation.

References:

1. Essentials of Food and Nutrition –Swaminathan M. Bangalore Press
2. Tietz textbook of clinical chemistry and molecular diagnostics edited by Carl. A. Burtis
3. Textbook of Medical physiology by Guyton and Hall
4. Text book of medical biochemistry by MN Chatterjea and Rana Shinde
5. Food microbiology -Adams, M.R. and Moss M.O.
6. Foundations in Microbiology -Kathleen Talaro and Arthur Talaro
7. Industrial Microbiology -Patel, H.P.
8. Industrial Microbiology –Casida
9. Industrial Microbiology -Prescott and Dunn
10. Microbiology -Concepts and Applications -Paul A. Ketchum
11. Microbiology Concepts and Applications -McKane and Kandel
12. Bergeys Manual of Determinative Bacteriology IX edition
13. Elements of Biotechnology - Gupta
14. Elements of Biotechnology - Singh
15. Food Technology Latest Issues

Paper-IV: BI 304T: Human Physiology and Xenobiotics (Core, 4 Credits; 100 Marks)

Unit – I: Neurophysiology

1 Types of neuronal cells – Neuroglia, microglia, astrocytes, oligodendrocytes, Schwann, satellite and epididymal cells
2 Nerves: regeneration of nerve fibers, generation of nerve impulse, all or none principle.
3 Mechanism of synaptic transmission, transmission of nerve impulse.
4 Types of neurotransmitters and their receptors, mode of signaling
5 Electrical synapse and giant neurons
6 Division of vertebrate nervous system: CNS, PNS, ANS, regions of the brain
7 Sensory organs – eye, ear, skin, tongue
8 Vision: visual system, rhodopsin and classical GPCR mechanism, termination of visual signal

9 Cone cells, specialization in color vision, physiology of colour blindness
10 Similarity between vision, olfaction and gestation

Unit – II: Structure and Physiology of Muscle
1 Structure of various types of muscle: striated, cardiac, smooth, fast twitch, slow twitch
2 Mechanism of muscle contraction, regulation of contraction
3 Role of actin and myosin in non-muscle cells.
4 Cytochalasins and cytokinesis.
5 Muscle gene expression, regulation at transcriptional and posttranscriptional level.
6 Role of muscle proteins in cell locomotion
7 Neuro-muscular transmission
8 Electromyography, Sherrington starling Kymograph (recording drum)
9 Disorders of muscle (dystrophy, myopathy, monocytisis, myotonia, paralysis, Myasthenia gravis)
10 Detection and treatment of muscle disorders

Unit – III: Human Reproductive Biology
1 Female reproductive system: anatomy and endocrinology
2 Causes of female infertility (acquired and genetic), treatments
3 Male reproductive system: anatomy and endocrinology
4 Causes of male infertility (environmental and genetic), treatments
5 Puberty, reproductive aging (menopause and andropause)
6 Gametogenesis and fertilization (natural and assisted (*in vitro*)), implantation and placenta
7 Milestones in first trimester of pregnancy (http://www.ehd.org/virtual-human-embryo/)
8 Milestones in second trimester of pregnancy
9 Milestones in third trimester of pregnancy, child birth
10 Placenta as source of stem cells, cord banking

Unit – IV: Liver and Xenobiotics
1 Liver functions, pharmacopeia drug deposition and mechanisms of drug detoxification
2 Cytochrome P450 enzymes, molecular biology, catalytic cycle, isozymes, inhibitors
3 Dose response relationship, drug-receptors interactions
4 Pharmacodynamics; pharmacokinetics
5 Phase I reactions - modifications
6 Phase II reactions - conjugation
7 Phase III reactions - modifications and elimination,
8 Environmental factors influencing drug metabolism
9 Effects and metabolism of model toxins: aflatoxins, bacterial exotoxins (types I, II, and III)
10 Nutrient drug interactions – I and II

References:
1. Human Physiology by Guyton and Hall Press Pub Saunders
2. Biochemistry, 4th Edition - Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
3. Human reproductive Biology by Jones and Lopez Pub
4. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, … White A, McGraw Hill

Semester III: Practicals

(Note: Each topic corresponds one Practical Session)

Paper-V: BI 305P: Recombinant DNA and Immunotechnology

1 Restriction digestion of DNA
2 Prepare competent cells
3 Transform competent cells
4 Blue-white complementation screening
5 Express heterologous protein in *E. coli*
6 Gene cloning (demonstration)
7 Purify IgG by gel filtration
8 Purify IgG by affinity chromatography
9 Characterize IgG by specific antibody (Western blot)
10 SDS PAGE of Ig fractions
11 Agglutination: ABO and D Ag typing
12 Radial Immuno diffusion
13Ochterlony double diffusion
14 Rocket immunoelectrophoresis
15 Dot ELISA
16 sandwich ELISA

References:

1. Molecular Cloning (Lab manual) by Maniatis T, Fritsch EF, Sambrook J, Volume –I, CSH
2. Lab Manual in Biochemistry, Immunology and Biotechnology – Arti Nigam and Archana Ayyagari –Tata McGraw-Hill New Delhi

Paper-VI: BI 306P: Nutrition and Clinical Biochemistry

1. Determine total protein content (Kjeldahl) in a food item
2. Determine total carbohydrate content in a food item
3. Determine lipid content in a food item
4. Qualitative analysis of abnormal constituents in urine
5. Determine PCV, ESR, differential count
6. Determine osmotic fragility of RBC
7. Laboratory test to measure coagulation
8. Determine urinary glucose
9. Determine urinary creatinine
10. Determine blood haemoglobin (Drabkins) and glycosylated hemoglobin
11. Determine blood urea
12. Determine blood glucose (POD-DOD method, enzymatic method)
13. Assay serum alkaline phosphatase
14. Assay serum ALT (SGPT)

15. Assay serum AST (SGOT)
16. Assay serum LDH

References:

1. Practical Clinical Biochemistry –Varley, H. CBS Publications
2. Practical Clinical Biochemistry-Methods and Interpretations – Ranjna Chawla- Jaypee
3. Manipal Manual of Clinical Biochemistry: For Medical Laboratory and MSc Students
By S. Nayak, Shivnanda Nayak B, JAPEE Brother Medical Publications, New Delhi

Paper-I: BI 401T: Biostatistics and Bioinformatics (Core, 4 Credits: 100 Marks)

Unit – I: Biostatistics-I

1 Biostatistics fundamentals (sample, population, variable); Types of variables, Measurement and measurement scales
2 Measures of central tendency (mean, median, mode)
3 Measurement of dispersion (range, variance, standard distribution)
4 Study of bivariate data: correlation and regression; Regression to calculate concentration of DNA/protein, molecular weight of DNA/protein
5 Graphical methods to depict data (histograms, bar-plots, pie charts, line graphs)
6 Probability in biology, Laws of Probability
7 Bayesian probability
8 Normal distribution.
9 Binominal distribution.
10 Poisson distribution

Unit – II: Biostatistics-II

1 Design of experiments: factorial experiments
2 Student's t – test
3 F – test
4 Chi – square test; Contingency tests
5 CRD: Completely Randomized Design; 1-way ANOVA
6 RCBD: Randomized Complete Block Design; 2-way ANOVA
7 Non parametric tests: sign test
8 Wilcoxon signed rank test, Mann-Whitney test
9 Kruskal-Wallis test, and Friedman tests
10 Quality control in biochemistry

Unit – III: Genomics

1 Genomics and branches of genomics (Why study a genome?)
2 HGP and Strategies for sequencing genomes (shotgun and hierarchical sequencing)
3 1st generation sequencing methods (Maxam and Gilbert Method; Sanger's method)
4 2nd and 3rd Generation DNA sequencing methods (Next Generation Sequencing)
5 Genetic and Physical maps of the genome, EST, STS
6 DNA sequence databases, Use of databases; data mining
7 Comparing DNA sequences, pairwise local and global alignment
8 BLAST, FASTA, PAM and BLOSUM matrices
9 Multiple sequence alignments (Phylogenetic trees, Clustal-W, COBALT)
10 Epigenomics and metagenomics

Unit – IV: Transcriptomics and Proteomics

1 Relation of transcriptome to genome and proteome (Why study a transcriptome?)
2 Tools of transcriptomics: Northern blots, RNase protection assays, RT-PCR and Q-PCR
3 HT tools of transcriptomics: Microarrays for expression profiling, alternate sequencing
4 HT RNA sequencing: SAGE, MPSS, RNA-Seq, GIGA
5 Identifying expressed sequences by ChIP-seq, DNase-seq
6Transcriptome databases (ESTs, Transcriptome Shotgun Assembly, ArrayExpress)
7 Methods for sequencing proteins: Edman degradation
8 MS – MALDI. LC-MS, Tandem MS (MS-MS)
9 Micro-arrays for proteins, 2D gels and peptide maps
10 Proteins structure databases; Peptide sequence and MS profiles databases, Comparing protein sequences, alignment

References:

1. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India
2. Biochemical Calculations –Segel, I.H. John Wiley & Sons.
3. Math's from Scratch for Biologists Alan J, Cann, John Wiley & Sons
4. Calculus for Biology and Medicine, Claudida Neuhauser (third edition) Publications Prentice Hall
5. Biostatistics –Arora & Malhan, Himalaya Publishing House
6. Introduction to Bioinformatics- Attwood T K and parry –smith, D.J. Pearson Eduction
7. Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH
8. Discovering Genomics, Proteomics and Bioinformatics – Campell & Heyer, Benjamin / Cummings pub

Paper-II: 402T: Cell-Cell Communication and Signal Transduction
(Core, 4Credits:100 Marks)

Unit – I: Extra Cellular Matrix (ECM) and Cell Surface

1. Molecules in the ECM in plant and animals.
2. Transport across cell membrane, Ficks Law.
3 .Types of transport- simple, passive, facilitated.
4. Active transport, primary and secondary active transport system.
5. Ionophores, gated channels (Voltage and Ligand).
6. Cell communication and type of signaling molecules.
7. Types of receptors and their structure.
8. GPCR, inhibitory and stimulatory and type of down steam effectors and signal termination.
9. Monomeric G-proteins their role.
10. Drugs targeting signaling molecules

Unit – II: Cell Signaling

1. Cell division and differentiation.
2. Autocrine, paracrine & endocrine systems
3. Growth factors – EGF, PDGF

4. VEGF, IGF
5. Second messengers – Ca, calmodulin, inositol, NO, cAMP, cGMP
6. Receptors tyrosine kinases (Insulin signaling)
7. MAPK pathway, role in signaling.
8. Role of post-translational modification of proteins in signaling – phosphorylation.
9. Acylation, glycosylation, ADP ribosylation, myristoylation.
10. Signal cascades, Inhibitors of signal cascades.

Unit – III: Signal Transduction and Cancer

1. Discovery of oncogenes, proto-oncogenes
2. Modes of action of oncogenes – G proteins – Ras
3. Growth factors – Erb, Sis
4. Transcription factors – Fos, Jun, AP1, V-erbA
5. Discovery of tumor suppressor genes
6. RB and retinoblastoma, APC and colon cancer.
7. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN)
8. p53 and cancer risk
9. Selected examples – c-Myc and leukemia
10. BRCA and breast cancer

Unit – IV: Signal Transduction in Bacteria and Plants

1. Introduction of signaling components in bacteria
2. Chemotaxis
3. Protein kinases in bacteria
4. His-kinases: structure and role
5. Plant signaling system an over view
6. Stress signaling in plants (biotic)
7. Stress signaling in plants (abiotic)
8. Plants hormones and their mechanism of action
9. Signaling in yeast
10. STAT pathway in yeast

References:

1. The Biochemistry of Cell Signaling, Helmreich JM, Oxford Press
2. Cell signaling – John T Hancock, Oxford University press
3. Cell biology. Second edition: Edited by C A Smith and E J Wood. Chapman & Hall publ
4. Molecular Cell Biology, 4th edition. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore and James Darnell. New York: W. H Freeman

Paper-III: BI 403T: Microbiology (Core, 4Credits:100 Marks)

Unit I: Bateriology

1. Classification of prokaryotes,
2. Staining methods,
3. Common culture methods (minimal,enriched, selective).
4. Structure of bacterial cell.
5. Motility of bacteria, bacterial films,
6. Sterilization methods (autoclaving, dry heat, filtration, chemical disinfectants, irradiation),
7. Maintenance and preservation of microbial cultures.
8. Bacterial culture growth conditions, growthcurve, doubling time.
9. Factors affecting growth –pH, temperature, oxygen and agitation.
10. Chemostat, continuous and synchronous cultures

Unit II: Mycology

1. Classification: classification of Fungi (Ainsworth, 1973) upto sub-division with diagnostic characters and examples.
2. Hyphal forms,
3. Fungal spore forms and mode of liberation,
4. Sexual reproduction and degeneration of sex,
5. Homothallism and heterothallism, life cycle patterns,
6. Anamorphic fungi and parasexuality 3.
7. Life history of synchytrium,
8. Life history of Rhizopus, Ascobolus,
9. Life history of Agaricus, Micorrhiza types with salient features,
10. Role in agriculture and forestry.

Unit III: Prokaryotic viruses

1. Discovery of bacteriophages
2. Structure and composition of bacteriophages; classification
3. Genome diversity and host-specific interactions
4. Isolation and purification by filtration, ultracentrifugation and affinity chromatography
5. Plaque assay and other assay methods
6. One step growth, single burst and eclipse experiments
7. Life cycle of model bacteriophages infecting E.coli – lambda phage (lytic and lysogenic)
8. Φx174,Qβ, M13
9. T4,T7
10. Phages in therapy

Unit-IV: Eukaryotic viruses

1. Classification of animal viruses, Viriods and virusoids
2. Structure of naked and enveloped viruses
3. Host-virus interactions, permissive/non-permissive hosts; cytopathic effects
4. Isolation and purification of viruses
5. Assay methods-Pock assay, hemagglutination assay, transformation assay

6. Cultivation of viruses in animals and tissue culture
7. Life cycle of animal viruses – SV40
8. Adenovirus, Poliovirus
9. Retroviruses – RSV/HIV
10. Plant viruses – TMV, CaMV

References:

1. The Fundamentals of Bacteriology by Charles Bradfield Morrey
2. Bacteriology Textbook by Charles P. Davis, Gail Woods and David Niese
3. Basic Bacteriology by C.C. Chen, Ph.D., D.D.S
4. Fungi Their Nature and Uses by Mordecai Cubitt Cooke
5. Biology of Fungi by Chet Cooper
6. An Introduction To The Study of Fungi by E. F. Legner
7. Basic Virology by Elliott J. Blumenthal by Elliott J. Blumenthal
8. Veterinary Virology by Dr. M. A. Oyekunle, Dr O. E. Ojo and Dr. M. Agbaje
9. Molecular Virology by Moses P. Adoga
10. Viruses of Prokaryotes by Hans-Wolfgang Ackermann, Michael S. Dubow
11. Viruses of Fungi and Simple Eukaryotes by Y. Koltin

Paper-IV: BI 404T: Biotechnology. (Core, 4 Credits: 100 Marks)

Unit – I: Microbial Biotechnology

1 Large scale cultivation of microbes; Fermenter design and control of growth
2 Downstream processing
3Production of biomass, single cell protein
4 Production of low molecular weight primary and secondary metabolites
5 Microbial insecticides
6 Production of enzymes for industry (high fructose corn syrup, cheese, food processing)
7 Microbial polysaccharides-Xanthan gum, Dextran, Pullulan, Mannan, Curdlan, Alginate
8 Microbial mining (mineral leaching)
9 Microbial production of interferon, tissue plasminogen activator
10 Microbial degradation of oil (bioremediation)

Unit – II: Plant Biotechnology

1 Plant cell culture: callus, protoplast fusion, differentiation into plantlets
2 Plant vectors, Ti plasmids
3 GM plants, GM foods
4. IPR and farmers' rights in GM plants
5 Anti sense RNA and DNA
6 Plantibodies
7 Case studies (genes involved, commercial value, problems) of StarLink corn, Bt cotton
8 Case studies of Zeneca tomato paste, FlavrSavr tomato
9 Case studies of Golden rice, Herbicide resistant plants
10 Virus resistant plants

Unit – III: Animal Biotechnology

1 Development, maintenance and growth of animal cell lines

2 Cloning of mammalian species (Dolly)
3 Production of viral vaccines
4 Production high value therapeutics, interferon
5 Plaminogen activator, urokinase
6 Monoclonal antibodies, chimeric antibodies
7 Immunotoxins as therapeutic agents
8 Gene knockouts and transgenic animals
9 Human gene therapy
10 “Humanized” animals as organ farms

Unit – IV: Protein Engineering
1 Methods and applications of immobilized cells
2 Methods and applications of immobilized enzymes
3 Large-scale and site-directed mutagenesis,
4 Natural and recombinant fusion proteins, tags for protein purification
5 Altering kinetic properties and pH dependence of enzymes
6 Increasing stability, enhancing specific activity of enzymes
7 Directed enzyme evolution
8 PEGylated interferon
9 Macro-modifications
10 Methods of drug design and delivery

References:
1. Introduction to Biotechnology, William J. Thieman, Michael A. Palladino, Benjamin Cummings Publ
2. Biotechnology- Arora, Himalaya pub. House
3. Principles of Gene Manipulation, by R.W. Old, S.B. Primrose, Wiley-Blackwell Publications

Semester IV: Practicals

(Note: Each topic corresponds one practical session)

Paper-V: BI 405P: Bioinformatics, Biostatistics and Biotechnology

1. OMIM database and human genetic disorders
2. Retrieve DNA, protein sequence from database (NCBI)
3. Retrieve protein structure from database (PDB)
4. KEGG database for pathways
5. Local, Global alignment of DNA, protein
6. Multiple sequence alignments
7. Descriptive statistics (mean, median, mode, range, variance, standard deviation)
8. Correlation and regression
9. Binomial, Poisson and Normal distribution
10. Z , T ,F and Chi-square tests
11. Polymerase chain reaction
12. Isolation of plasmid DNA
13. Production of alcohol by *saccharomyces cerevisiaceae*
14. Production of any microbial enzyme

15.Culturing of plant animal cell or tissue
16. Immobilization of cells

References:

1. Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH
2. Biostatistics by con and conum
3. Biostatistics –Arora & Malhan, Himalaya Publishing House
4. Methods In Biotechnology, edited by Hans-Peter Schmauder. Taylor & Francis

Paper-VI: BI 406P: Project

Department of Biochemistry,UCS&I,MGU,Nalgonda
Semester – III, Interdisciplinary paper-I (C.B.C.S)
w.e.f 2015-16 admitted Batch

Subject: **Chemistry of Biomolecules and Methods of Study**

Unit-I: Chemistry of Biomolecules and Metabolism

Introduction of Biochemistry and evolution (outline only).Water properties, interactions, pH scale, buffers.Biomolecules (aminoacids,proteins, polysaccharides, lipids and nucleic acids) classification, chemical nature, structure and functions. Peptide bond. Outlines of metabolism of proteins, polysaccharides, lipids and nucleic acids.

Unit-II: Biocatalysis and Bioenergetics

Introduction to enzymes. Nomenclature and classification of enzymes, Difference between chemical and biological catalysis.Specific activity, Metal and cofactor requirements, Factors effecting rate of reaction: pH,Temperature,Pressure,Michaels Menten Kinetics,Types of enzyme inhibitors, Allosteric proteins and cooperativity. Laws of thermodynamics, Gibbs free energy, Entropy, Enthalpy. High energy compounds, ETC in mitrochondria, Bioluminescence

Unit-III: Instrumental Methods-I

Beer Lamberts Law, Molar extinction coefficient, Colorimetry-Principle, instrumentation, application, UV-Vis spectroscopy -principle, instrumentation, application, NMR, ESR-principle, instrumentation, application, Mass spectrometry -Principle, instrumentation, application. Fluorescence spectroscopy -principle, instrumentation, application, X-Ray crystallography.

Unit-IV:Instrumental Methods-II

Partitioning and counter current distribution, PC- principle, instrumentation, application,TLC-principle, instrumentation, application, Affinity chromatography-principle, instrumentation, application,Gel filtration (gel exclusion chromatography)-principle, instrumentation, application, Ion exchange chromatography-principle, instrumentation, application, GC- principle, instrumentation, application, HPLC-principle, instrumentation, application.

Department of Biochemistry, UCS&I, MGU, Nalgonda
Semester – IV, Interdisciplinary paper-II (C.B.C.S)
w.e.f 2015-16 admitted Batch

Subject: **Clinical Biochemistry, Nutrition and Immunology**

Unit-I: Clinical Biochemistry

Clinical importance of Enzymes and isoenzymes
Normal values for different blood tests and clinical implications
Clinical diagnosis of human diseases: anaemia, thalassemia
hyper cholesterolemia, atherosclerosis, diabetes, Pregnancy test.
Liver function tests: conjugated and total bilurubin in serum, albumin: globulin ratio,
Liver diseases: jaundice, hepatitis.

Unit-II: Nutrition

Biological buffers. Acid base balance
Balanced diet, Calorific values of foods and their determination by bomb calorimeter.
Specific dynamic action of foods, BMR, RDA for infants, children, adults and expectant / nursing mothers, Malnutrition (PEM, Marasmus, Kwashiorkor), Eating disorders; Anorexia and bulimia; Obesity and Starvation.

Unit-III: Immunology-I

History of immunology, Classification, structure, and biological properties of immunoglobulins, Isotypes, allotype, idiotypes.
Natural & acquired immunity, Specific & non-specific immune response. Cells & organs of immune system, Antigenic determinants, Epitopes, Haptens, Properties of strong antigens, Adjuvants – types, mode of action and applications.

Unit-IV: Immunology-II

Humoral & cell-mediated immune response
Activation of T cells & B cells. MHC proteins structure & functions
Antigen processing & presentation, Hypersensitivity, Auto immune diseases; classification
Production of monoclonal antibodies
Immunoprecipitation methods - gel diffusion (Ouchterlony; Mancini);
Immune-electrophoresis (Rocket), Agglutination tests, ELISA, RIA, Western Blots;